

## CLAIMS

1. A mapping-projection-type electron beam apparatus for observing and/or evaluating a surface of a sample by  
5 irradiating the sample with a primary electron beam and causing reflected electrons emitted from the sample to form an image on a detector, said apparatus comprising:  
an electron impact-type detector such as an electron impact-type CCD and an electron impact-type TDI as said  
10 detector for detecting the reflected electrons, said detector capable of selectively detecting the reflected electrons on the basis of an energy difference between the reflected electrons and secondary electrons emitted from the sample.
- 15 2. An electron beam apparatus as claimed claim 1, further comprising an image processing mechanism for processing the output of said electron impact-type detector to produce an image for evaluation and inspection, wherein a gain of said electron impact-type detector and an amount  
20 of exposure of the image for evaluation and inspection are adjusted by changing the energy of the primary electron beam incident on the sample.
3. An electron beam apparatus as claimed in claim 1 or 2, wherein the energy of the primary electron beam incident  
25 on the sample is 2 to 4 keV thereby charging the surface of the sample negatively so as to reduce image distortion due to charge-up on the surface of the sample.
4. An electron beam apparatus as claimed in any one of

claims 1 to 3, wherein the landing energy of the primary electron beam on the sample is set to 0.2 to 4.0 kV thereby improving an S/N ratio by detecting said reflected electrons and backscattered electrons.

5 5. An electron beam apparatus as claimed in any one of claims 1 to 4, further comprising cooling means for cooling the electron impact-type detector to reduce heat generated due to electron bombardment.

6. An electron beam apparatus for irradiating a sample  
10 surface placed in a sample chamber with a primary electron beam so as to evaluate the sample surface on the basis of a secondary electron beam emitted from the sample surface, said apparatus comprising:

means for supplying a gas so as to uniformly cover  
15 the sample surface, charge-up on the sample surface being reduced by contact between the sample surface and the gas.

7. An electron beam apparatus as claimed in claim 6, wherein the sample is mounted on a stage provided in the sample chamber, said means for supplying the gas having a  
20 cover for covering the sample mounted on the stage, said cover having at least one gas inlet.

8. An electron beam apparatus as claimed in claim 6 or 7, further comprising an electron source which is provided separately from a primary electron source for generating  
25 the primary electron beam, said electron source capable of irradiating the sample surface with electrons.

9. An electron beam apparatus as claimed in claim 8, wherein said electron source provided separately from the

primary electron source radiates electrons at an energy level of 2 to 4 keV.

10. An electron beam apparatus as claimed in claim 8 or 9, wherein said electron source provided separately from  
5 the primary electron source is of a carbon nanotube-type cold cathode electron source.

11. A method of manufacturing a semiconductor device, comprising a step of evaluating a wafer in the course of processing, by using the electron beam apparatus according  
10 to any one of claims 1 to 10.

12. A method of evaluating a sample surface by irradiating the sample surface with a primary electron beam so as to evaluate the sample surface on the basis of a secondary electron beam emitted from the sample surface,  
15 said method comprising a step of supplying a gas to uniformly cover the sample surface so as to neutralize the sample surface negatively charged up, the pressure of the supplied gas being in a range of 0.01 to 0.1 Pa.

13 A method as claimed in claim 12, wherein the gas  
20 introduced into the sample chamber is one selected from a group comprised of nitrogen, water vapor, a halogen gas having high affinity to electrons and a chemical compound thereof.

14. A method as claimed in claim 12 or 13, wherein an  
25 electron source other than a generation source for the primary electron beam is prepared; the sample is irradiated with electrons from the electron source; the sample surface is thereby charged up negatively; the charge-up is

neutralized by the gas; and evaluation of the sample surface by means of the primary electron beam is thereafter performed.

15. A semiconductor device manufacturing method
- 5 comprising performing wafer evaluation at an intermediate stage in the process by using the sample evaluation method according to any one of claims 12 to 14.